

THE PROGRESSIVE FISH CULTURIST

NEWS AND VIEWS FROM MANY SOURCES ON PRACTICAL HATCHERY PROBLEMS



ISSUED BY THE

U. S. DEPARTMENT OF COMMERCE

DANIEL C. ROPER, SECRETARY

BUREAU OF FISHERIES

FRANK T. BELL, COMMISSIONER

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THE PROGRESSIVE FISH CULTURIST

A SERIAL memorandum published occasionally for the advancement of Federal, State, and private fish culture and fishery management in fresh waters.

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DEVELOPING TROUT AND SALMON FISHING IN LAKES

By W. M. Keil

U. S. Forest Service, Asheville, N. C.

WITH THE PASSING of time, there has come such a rapid increase in the number of persons whose recreational preferences turn towards angling, that public trout fishing if it is to be preserved at all must be largely maintained in lakes rather than streams. It will be biologically impossible for any except a few of the larger streams to support sufficient trout to provide even a few days' sport to those living adjacent to such waters. And where the number of local anglers who fish these streams are multiplied many times by visitors from considerable distances, no amount of heavy restocking will suffice to prevent a state of almost continual depletion.

On the other hand, lakes that have physical and biological conditions suitable for certain species of trout and salmon, can be built up and maintained as veritable fisherman's paradises. The New England States are rich in such waters. New York State alone has a sufficient number of large and small public trout lakes to provide excellent sport for hundreds of thousands of anglers. No person in the United States should find it necessary to travel to Canadian waters in search of such fishing as he desires, when nature has been so generous in the number of ideal trout lakes scattered over our northern states. Most of these can be made to yield abundantly, even though most of them originally contained, or have been injudiciously planted with the so-called predatory species such as bass, perch, pike, and pickerel.

We in America should be ashamed of the fact that many of the comparatively small lakes in the British Isles provide year after year far better trout fishing than is to be found in the majority of our own public waters. Years ago the Britishers found it a waste of time and money to attempt to maintain good fishing in these lakes by planting fry and fingerlings and that only by periodic restocking with yearling fish could a large proportion of those planted be retaken by anglers. We also have abundant evidence of the value of this method of stocking lakes through the experiences of many clubs and owners of private preserves.

There has been too little attention given to the development of trout fishing in lakes, even where conditions are particularly favorable. In many states containing numerous, natural trout lakes, too large a proportion of the money available for fish cultural work has and is being spent in attempting to maintain even mediocre fishing in streams that are known to be unproductive in results. Say what you may about the poetry of stream fishing, the average angler today would be far better satisfied could he motor to some lake landing; hire a boat; and spend the day casting, trolling or even deep still-fishing, had he a reasonable chance of coming back with several good sized trout or salmon. With better fishing of this type provided for the general public, there would be less tendency on the part of the anglers to converge by thousands on the few remaining streams that will support trout and clean out such waters in a few days' fishing. Lake fishing, such as can be developed, might enable those in charge of our fishery work to maintain a fair amount of trout fishing in streams for those who prefer this type of angling above all others.

It has been said that good trout and salmon fishing cannot be built up or maintained in lakes where bass or other spiny-finned species have been introduced and are present in quantities. This may be true in a few instances, but by no means in the majority of cases. Certainly such species are not a desirable addition to those waters where they do not exist at present; but the fact that so many otherwise ideal trout lakes already contain such fish should not eliminate these from consideration as suitable habitat for trout and salmon.

Under average conditions, it is much easier to develop and maintain attractive trout and salmon fishing in lakes than in streams. Either requires plenty of money to do the job right, but all things considered the actual returns in dollars and cents to local hotels and boarding houses, merchants, guides, boat liveries, etc., is far greater when good fishing is to be had at lake resorts, than might be developed under comparable efforts in even the best of streams. And it is certain that a larger per cent of the angling public would feel that they were getting a better return for their money.

Ordinarily, fish grow more rapidly and to a larger size in lakes than in streams. The food is usually more abundant or at least it may be developed to provide a more nearly abundant year round diet. The loss of fish from predators is much less in lakes than in streams and certainly no one will dispute the fact that the control of illegal fishing is more effective.

Good fishing for trout or salmon or both cannot be built up or maintained by dumping a few thousand fingerling fish into a lake of several thousand acres and then waiting for several years to see what happens. It must first be determined just what variety or varieties are best adapted to the particular water in question; and the selection of the species and the decision as to the proper number and sizes to be planted must be based upon something better than guess work. Nearly every lake of any prominence in the country has at some time been examined by aquatic biologists and fish cultural investigators. Many thousands of dollars have been expended in the past few years in carrying out such surveys; but in most instances the findings of these scientific investigators have been so technically presented as to have little or no value to the practical minded fish cultural workers who are presumed to make use of the collected material. These trained specialists are necessary in describing in minute details the organisms and biological and chemical factors that produce certain

conditions; but in their summarizing, they are not able, or at least have neglected in most instances, to indicate the significance of their findings in relation to fish cultural application. Conspicuous by their almost total absence in these reports of investigations are records of the species, abundance, sizes, and condition of the original fish life. Seldom is there included any definite conclusion as to the reasons for the total disappearance of certain species or the scarcity of others, as well as data on the results of attempts to restock the water with native or non-indigenous species.

Certainly if any real benefits are to result from these often expensive surveys, the mass of accumulated data must be broken down into such form that practical, workable conclusions may be drawn from them. The conditions that have been found to exist in lakes of similar characteristics should form a basis for grouping together types of waters where the chemical analyses indicated a similarity of softness or hardness, acidity or alkalinity, and percentages of dissolved gases. There should be a close relationship in the types of water plants, crustaceans, mollusks, insect larvae, and minnow life that could be supported under these conditions. Such environments should be indicated as particularly favorable for certain species, and the numbers and sizes of these species for planting each season should be recommended to the fish cultural department for their attention. This is the primary purpose for such investigations and the conclusions and recommendation in the final summary should be made so clear that no misunderstanding could arise.

You cannot have good angling without suitable and abundant fish food, regardless of the "old women's tale" mouthed about at many fishing resorts that the fish are not biting because there is too much food. This is one of the most important requirements in the development and maintenance of good fishing anywhere. There are many excellent varieties of both shoal and deep water small food fishes whose cultivation for replenishing depleted waters have been sadly neglected. In the writer's opinion, the lack of suitable food fishes in many of our trout and salmon lakes has been one of the largest contributing factors towards failure to develop worth while fishing. In our northeastern lake country aside from smelt, there are several sub-species of small whitefishes that are the natural food of the trout and salmon. The adirondack frostfish (Coregonus (Gadrilateralis)) is one of the finest of these. Artificial propagation and restocking with this species has been discontinued for many years past. In this region, the lake chub (Couesius) also serves as an ideal forage food while the trout or salmon are in shallower waters during the spring and fall months. Its cultivation or transfer from well stocked to depleted waters has received little or no attention. Throughout the north central states, the lake ciscos (Argyrosomus or Leucichthys) are preferable in most instances to smelt as foods for salmonoids. In the inter-mountain and Pacific Northwest sections, the Rocky Mountain whitefish (Coregonus williamsoni) and Columbia chub (Mylocheilus) are the two most valuable food species to be encouraged. In these western waters the local variety of silver-side shiner or dace (Leuciscus) should be introduced where absent, to provide a forage fish in the shallower areas of the lakes. In every part of the country where more attractive trout and salmon fishing is hoped to be developed and maintained, this supply of suitable foods should be made an important part of the program.

All those who have been closely identified with the development or administration of public fishing are familiar with the periodic howl that goes up about the numbers of undersized trout that are badly hooked and released during the open season in most of our streams. It is a curious fact, borne out by careful observations and records over many years at certain lake resorts, that even when thousands of yearling trout and salmon are planted annually in good sized lakes such fish are seldom retaken by anglers during the first fishing season following. Either these immature fish are not attracted by the types of lures usually used in lake fishing, or for the first year at least, do not frequent the localities or depths regarded by local anglers as the best fishing grounds.

In lakes that are comparatively small - from 25 up to 100 acres with a maximum depth of 30 or 40 feet - brook trout are perhaps the best variety for introduction. Neither brook nor brown trout produce satisfactory angling in the larger deep lakes, especially those without large tributaries emptying into them. They may thrive in such waters and grow to large sizes, but they do not provide the kind of fishing the public expects and should have. Lake trout should never be planted in bodies of water of less than a thousand acres. This exceedingly voracious species of trout requires plenty of range and a tremendous amount of food (chiefly in the form of fish) and when present in small lakes, simply devour their own kind until only a few large specimens remain. For the average, clear, deep lake of from 200 acres upward, no species of trout has been found superior to the steelhead or rainbow. With the exception of a few of our lakes that are normally high in acidity, most of our northern waters are well adapted to these species. As to game qualities, there is no comparison between the bulldog tugging of the lake trout, or the half-hearted struggles of the brook and brown trout when hooked in lakes, to the spectacular fighting of the rainbow and steelhead. Even in lakes of the inter-mountain region and the Pacific Northwest, these species almost without exception produce a better brand of lake fishing than varieties of the cutthroat or black-spotted trouts.

This eulogy regarding the steelhead and rainbow trouts should not be construed as meaning that the writer recommends the indiscriminate planting of these species in all waters where conditions are favorable. There are scores of lakes (especially in the New England States) where no variety will ever replace in suitability or popularity the landlocked salmon or ouananiche. In most of such waters, there are no biological or fish cultural reasons why splendid fishing for landlocked salmon cannot be maintained. There are perhaps more anglers in the New England States who go in search of landlocked salmon and in doing so spend more money than for any other fresh water variety. And they deserve a better break than they are getting at the present.

In such waters where landlocked salmon thrive and where conditions are favorable for a certain amount of natural reproduction, the planting of other species of trout and salmon should be discouraged, but where good fishing for this variety must be maintained largely through annual restocking, then the addition of rainbow or a non-migratory type of steelhead cannot be regarded as detrimental, and usually provides much better fishing throughout the season than would be furnished by one species alone. The fact that fishing for landlocked salmon is usually at its best early in the season was largely responsible for the summer people at lake resorts insisting that black bass and other related species be planted to furnish them something to

catch during the midsummer months. Rainbow and steelhead do not range as deep as do other species of trout during mid-summer, and in most lakes can be readily taken by trolling and occasionally by fly fishing during early morning and late evenings throughout the season.

If best results are to be expected from these fish, they should be held over into the yearling stages before being planted. That is the time when they would normally migrate down into the lake from the stream in which they were hatched and had passed the earlier stages of their life. Much better results will be had by planting several thousand 18 to 20 month old fish directly into the lake than turning out ten times the number of even good sized fingerlings into tributary streams. There are exceptions of course, but in the general run of averages it is not only more economical but also far more productive in good fishing to rear the fish to the yearling sizes. There are good and sufficient reasons why those species of trout and salmon that spawn in running streams should not be planted directly into lakes as fingerlings but space will not permit this matter being dealt with in the present article.*

The number of trout and salmon in the yearling sizes that should be planted each season to provide good fishing must depend on the size of the lake, the proportion of shallow to deep water areas, the character and amount of the food supply, and to a large extent on the quantity and condition of the fish removed by angling. In calculating the area of the lake that will support such species through the season, those portions with less than 25 feet and greater than 100 feet in depth should be disregarded. As an illustration, if the lake contains 1,000 acres of surface area of which approximately 200 acres have a depth of more than a 100 feet and 300 acres less than 25 feet, then the favorable portion for supporting these species should be placed at 500 acres. If deep water food fishes are present in sufficient quantities, such a body of water should be able to support in good condition approximately 30 fish up to several pounds in weight each to the acre. In other words, 15,000 yearling trout or salmon would be an ample number for the initial stocking of such a body of water. For a large part of the season, these fish will range over parts of the lake that are less than 25 feet in depth, but during mid-summer (except in waters at high elevation) most salmonoids will resort to depths between 40 and 90 feet. In determining the number of fish for restocking, those in charge of the work should make provisions for recording as nearly as possible the fish removed by angling. This is not difficult at most lake resorts. Persons who have boats for rent are usually more than willing to keep such reports, especially if they are informed as to the value of such records. Owners of private camps and cottages who go out in their own boats can ordinarily be relied upon to comply with such requests. Some such records as these are necessary if good fishing is to be maintained. It is not enough to say that the fishing is heavy, medium, or light. Investigation should be made frequently while the fishing is in progress as to the growth and condition of the fish that are being taken out.

*The Biological Significance of the Smolt Period in Certain Salmonoids, Proceedings of the American Fisheries Society, 1922.

Best results have followed the planting of yearling fish quite late in the fall, when the surface and deeper waters are becoming more uniform in temperature. In lakes where the shore areas are frequented by large numbers of bass, pike, or pickerel, it is best to tow these fish in a floating live box out over the deep water sections and release them a few at a time over considerable areas. By the time some of them have reached the bass territory nearer shore, they have become well scattered and alert and few, if any, are devoured by these predators.

As examples of private waters in which rather remarkable angling for steelhead trout and landlocked salmon was built up and maintained for many years, the results secured at Tuxedo and Sterling Lakes in southern New York are worthy of recording. Neither of these lakes have any unusual qualities to which the excellent results might be attributed. They are just average, clear, deep lakes such as are to be found by hundreds throughout our northern states and Canada. In fact, few people will believe that such fishing could be developed within 35 miles of the heart of New York City. Tuxedo Lake is a natural spring fed body of water some 300 acres in area. The maximum depth is 83 feet with an average of 50 feet. There are comparatively few shoal areas, not more than 25 acres of the total having less than 25 foot depths. The tributary streams are small and usually become extremely low during the late summer and autumn. When Tuxedo Park was established in the early 1880's this lake already contained several introduced species in addition to those native to it. The indigenous species were suckers, yellow perch, rock bass, sunfish, pickerel, bullhead catfish, and a few brook trout. Smallmouth black bass had been introduced back in the 70's as well as that infamous importation, the German carp.

After the opening of the Tuxedo Club in 1886, a fish hatchery was established and an attempt made to build up trout fishing by planting fingerling brook trout in large numbers. The results were negligible, though for a number of years during the 90's the brook trout were reared and planted as yearlings and two-year olds. A few hundred of such fish would be taken each season close to the mouths of the tributary streams shortly after the ice had gone out of the lake in the spring, but aside from this provided no fishing at all. In 1895, eggs of the famous ouananiche from Lake St. John, Quebec, were procured, hatched, and the resulting fish planted as fingerlings with no results. In 1897, an additional consignment of ouananiche eggs from Lake St. John were received and the fish carried over until the fall of 1898 before being planted. Also, 50,000 steelhead eggs from the Columbia River collections were consigned from the U. S. Fish Commission, as it was called at that time. The results of this hatch were also held over into the yearling sizes before being released. No records are available as to just how many of these yearling steelhead and ouananiche were planted in 1898, but when the writer arrived on the scene in June, 1900 to take charge of the fishery work, the members of the club were wildly excited over the few hundred salmon and steelhead that had been taken that season. It was decided at that time that no further planting of brook trout would be made in the lake and that all salmon and steelhead would be held until the fall of the second year before being released. The spring of 1900, 10,000 eggs of the landlocked salmon from Craig Brook, Maine, and another shipment of steelhead eggs from Oregon City, Oregon, were received and the resulting hatch carried through until the fall of 1901. During the fishing season of 1902, in addition to several hundred larger trout and salmon, a number were taken weighing about a pound. With the opening of the season

in 1903, these fish began to be taken in large numbers, the salmon averaging about 2 pounds and the steelhead slightly heavier. Several thousand were recorded at the various boat houses. In no angling water in the world has there been a more careful record kept, not only for the numbers and sizes of the trout and salmon planted, but also the sizes, numbers, and condition of those retaken as well. These records show that with the exception of a period of years that will be mentioned later better than 50 percent of all trout and salmon planted during more than 30 years were recaptured by anglers. Little, if any, natural reproduction occurs from the salmon and steelhead in this lake so it is almost a certainty that all fish taken are the results of artificial propagation.

Although splendid fishing has been enjoyed by the members and guests of the Tuxedo Club during the years of 1903, 1904, and 1905, and the records gave a catch of approximately 6,000 steelhead and salmon each season, a change occurred in the personnel of the club Fish Committee, and as is usually the case, some new scheme had to be tried out. The rearing of some 10,000 steelhead and salmon to a length of 8 to 10 inches was said to be too expensive. Having consulted a number of outside authorities who advised the Committee that the same results should be obtained at less cost by planting 100,000 fingerlings, instructions were given the hatchery to plant this number instead of the usual stocking of larger and older fish. During the autumns of 1906-7-8 this procedure was followed and the fishing records for the next few years clearly illustrate the error of such a change of policy. From over 6,000 fish in 1906, the catch dropped to 3,107 in 1907; 1,644 in 1908; and 786 in 1909. There was an "Indignation Meeting" of the members in 1909 which resulted in a change of heart in the Committee and a readoption of the former plan of planting yearling fish. The records for 1910 show only 30 fish as being taken by the few disgruntled anglers who did go out. To rebuild such fishing as had been enjoyed previously required time, and it was not until 1912 that the recorded low of 30 fish in 1910 had risen again to over 4,000.

Somewhat similar in area and physical characteristics to Tuxedo Lake, although having a greater maximum depth and slightly harder water, Sterling Lake lying just north of the Jersey line in New York has also produced some rather unusual fishing for steelhead and salmon. Unlike Tuxedo Lake whose surrounding hills are dotted with a hundred or more large country estates, Sterling Lake's watershed and shore line remain much as they were a hundred years ago. This body of water, the bottom of which is composed of white sand and rocks, supports only a meager plant life, and originally contained as native species of fish, brook trout, yellow perch, sunfish, rock bass, and several varieties of shore minnows. Some time in the early 1880's lake trout were planted and in the fall of 1887, Mr. Abram S. Hewitt was instrumental in placing in this lake a number of Alpine saibling, the result of eggs sent to this country from the Swiss Lakes through the courtesy of Baron von Behr. These splendid charrs established themselves in this lake and apparently found the conditions unusually favorable for not only were a great many taken by anglers but also for a number of years were observed in great schools spawning on the reefs and sand bars. In a small lake of this kind, they could not long withstand the voraciousness of the lake trout and by 1900 had apparently been completely exterminated. It is to be regretted that this body of water at that time contained "lakers" for this was the only lake in this country in which these beautiful saibling from the Alpine country ever became even temporarily established.

In 1918 the writer was engaged by the Midvale Steel Corporation, who controlled this property at that time, to make an examination and report upon the prospects of building up and maintaining worth-while fishing. A careful investigation disclosed that with the exception of a somewhat depleted food supply and a lack of tributary streams for reproduction, all other conditions were well adapted to either the ouaniche or steelhead or both. It was also found that conditions were favorable for building up a desirable and ample food supply by the introduction of suitable food fishes, for despite the lack of higher vegetation, the water swarmed with microscopic crustaceans upon which these small food varieties subsist.

Following the report, authority was given to go ahead with the plans for developing the fishing, and as a preliminary step towards reestablishing an ample and suitable food supply, 3,500,000 smelt fry were planted in the spring of 1919. In October 1919, approximately 2,000 landlocked salmon yearlings and the same number of steelhead, averaging 9 inches were turned out. During the fall of 1920 the lake was again planted with 4,000 of the same sized trout and salmon. In the spring of 1921, 3,000,000 more smelt fry were released and in the fall of the same year 3,000 yearling steelhead and salmon. With the opening of the fishing season in 1921, hundreds of these fish were taken, averaging about 2½ pounds and later in the same year running up to 4 pounds in weight. It must be kept in mind that this was a strictly private lake and only officials of the Steel Company and their guests were permitted to fish. No records were kept by those in direct charge of the lake, either as to numbers taken or the weights; but the writer caught a number of fish of both species in 1922 that weighed from 3½ to 5 pounds. These fish were the most splendidly proportioned and beautifully marked landlocked salmon and steelhead trout that the writer has ever seen and were the equal in fighting qualities to any in the Maine or Canadian lakes or in streams of the Pacific Northwest. Those interested in keeping this lake well stocked lost control of this property in 1922 and the planting of fish was discontinued. After a few years of rather good angling, the number taken began to show a rapid decrease and within five years after the last fish were planted, only an occasional one was reported as being caught.

Many other similar instances in the experience of the writer might be mentioned as illustrating how good fishing might be built up in lakes by the systematic stocking with suitable varieties and close attention to the food requirements. It may be contended by some that such a procedure might work out all right in private lakes where there is plenty of money available but impractical for application to public waters. A few thousand dollars properly expended at almost any one of our major fishing lakes will undoubtedly repay itself many times over in direct and indirect returns to such communities.

A CLASSIFICATION OF MINNESOTA LAKES FOR FISH PROPAGATION

By Prof. Samuel Eddy, Biology Department
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THE LIMNOLOGISTS have developed several classifications for lakes based on various characters, which are rather complicated and somewhat difficult for the fish culturist to use in planting fish. A classification for the purpose of designating the type of the lake best suited for certain species of game fish has been developed in Minnesota. This classification is based on information gained from surveys of hundreds of Minnesota lakes.

These surveys have been carried on for many years with the cooperation of the United States Forest Service, the State Department of Conservation, and the State E.C.W., and during the past season was aided by the W.P.A. Physical, chemical, and biological surveys have been made of over 200 Minnesota lakes representing most of the types found in the state. The work of the surveys has been carried on chiefly during the summer months of June, July, August, and September. All lakes were surveyed two or three times during this summer in order to obtain an average of the summer conditions. On a number of lakes, surveys were continued all through the year in order to determine whether the summer conditions were representative of the general conditions of the lake and could be used comparatively.

The physical conditions were determined by first mapping the depths and bottom types. The area of each bottom type within certain depths was then computed. Determinations of temperature, oxygen, carbon dioxide, carbonates, and total dissolved solids were made at all depths. In many cases complete mineral analyses were made of the water, but this procedure was abandoned because of the labor involved. The amount of possible food material or animal life in the lake was computed by making numerous bottom samples from known areas of the various types of bottoms at all depths. The contents of these samples were sorted and counted as to the numbers and the species of organisms, and then dried and weighed. Knowing the area of the various bottom types at different depths, the total amount of bottom fauna in the lake was easily computed. The plankton or microscopic life in the open water was determined by making silk net collections at all depths, which were likewise counted, dried, and weighed. In this way the average summer condition of bottom fauna and of plankton was determined for each lake.

In each lake many seine hauls and gill net sets were made to determine the species of fish present in the lake and to find out which species was the most common or characteristic species. The result of this survey was a measurement for each lake of all the physical, chemical, and biological conditions for fish life and a determination of the most abundant species of fish associated with the various sets of conditions. The general productivity of the lake was also indicated through the measurements of these conditions for fish life.

The lakes of Minnesota can be classified into certain types suitable for certain species of fish. Naturally with so many lakes, some do not fall into these categories but are intermediate stages. This classification is to determine only the type of lake suitable for the various species of fish. It is impossible to survey each of the 11,000 lakes in Minnesota, but by surveying a sufficient number and determining the sets of conditions which indicate the various types a classification can be developed which, by noting several outstanding conditions will designate the fish suitable for most of the other lakes in the state. The number of fish a lake can support depends largely on the degree of productivity or fertility and is only partly considered in this classification. The lakes of Minnesota may be classified under these conditions as follows:

TROUT LAKE

The type of lake suitable for lake trout should be a deep lake ranging from 70 to 200 feet or more in depth. The area may be large or small. Tributary streams are usually present in this type of lake. The shores are composed largely of rocks and boulders. These are the coldest of the Minnesota lakes. The summer temperatures of the surface waters of most of the inland trout lakes range from 60° to 75° F. while the bottom temperatures range from 40° to 45° F. The difference between the bottom and surface temperatures usually ranges from 20° to 30° F.

The water is low in carbonates (10 - 50 p.p.m.) and may be referred to as soft. Such a lake is relatively infertile, supporting very little vegetation and bottom fauna. The amount of plankton or microscopic life in the open water is lower than that of any of the other lakes in the state. The surrounding land area is generally composed of thin rocky or relatively infertile soils. A thermocline or thermal stratification of the water is present in the lake and the colder waters below the thermocline contain abundant oxygen throughout the summer, due mostly to the fact that the animal and plant life and decomposing organic material, which are the consumers of oxygen, are rather scarce. Fishes occur at all depths. In these lakes the characteristic fishes are lake trout, white fish, ciscoes, lawyers or eel pouts, perch, and suckers. In Minnesota these lakes occur in the region along the border from Lake of the Woods to Lake Superior. Lake Superior, although exhibiting extreme conditions of depth and low temperature and possessing no definite thermal stratification, probably belongs in this category.

PIKE LAKE NO. 1.

This type of lake is moderately deep, ranging usually from 30 to 70 feet, and from a mile to five or more miles in diameter. The conditions of tributary streams, shores, vegetation, bottom fauna, plankton, and carbonates is similar to that of the trout lake. These lakes are not as cold as the trout lakes mainly because they are not as deep. The summer temperatures of the surface waters range from 60° to 75° F. while the bottom temperatures range from 44° to 55° F. The difference between the summer surface and bottom temperatures is usually from 10° to 20° F. A thermocline is present but because of the relatively small volume and depth of the colder water below the thermocline, oxygen is usually insufficient for fish life in the lower stratum

during the summer months. The characteristic fish of this type are wall-eyed pike or pike perch, pickerel, eel pout or lawyers, perch, and suckers. In some cases lake trout and ciscoes or tullibee may occur but usually they are not abundant. If the lake is smaller in area the wall-eyed pike are frequently absent. In many of these lakes in northeastern Minnesota, wall eyed pike were not present originally but the suitability of this species has been clearly demonstrated when they have been planted in these lakes. Several cases are known of lakes of this type where bass, crappie, and sunfish occur. In some of these lakes, these fish were abundant but were under size and apparently not living under conditions best suited for them. These lakes are common throughout the Superior National Forest.

PIKE LAKE NO. 2.

This type of lake is moderately deep ranging from 30 to 100 feet. The area is very large, the lakes ranging over six miles or more in diameter. Tributary streams are present in all of the lakes of this type which have been studied. The shores are composed of sand, gravel, and mud. The summer temperatures of the surface waters range from 68° to 75° F. or even higher. The bottom temperatures usually range from 65° to 70° F. during the summer. The difference between the surface and bottom temperatures during the summer is seldom very great, usually ranging from 1° to 5° F., although usually not more than 3° F.

The surrounding drainage area consists of relatively fertile soil. The bottom is rich in organic matter and supports abundant vegetation and bottom fauna. The plankton is usually very abundant. The wave action is usually strong and causes currents or undertows. Usually there is no thermocline or thermal stratification present except for short periods, when there are no winds, and consequently although the oxygen consumption is high, the oxygen at the bottom is sufficient for fish life throughout the summer. The characteristic fishes for this type of lake are wall-eyed pike, pickerel, and suckers. Perch and sometimes blue gills and other sunfishes may also be abundant in this type of lake. Ciscoes may occur occasionally. Red Lake, Mille Lacs Lake, Lake Winnibigoshish, and Leech Lake are outstanding examples of this type.

PIKE AND BASS LAKES

Lakes of this type are moderately deep ranging from 30 to 150 feet. They are usually quite large ranging from two to five miles in diameter or length. Tributary streams are usually present. These lakes have shores composed mostly of sand, gravel, and mud. The surface temperatures range from 70° to 80° F. during the summer. The bottom temperatures vary according to the depth. Lakes of this type which are over 80 feet deep may have bottom temperatures as low as 45° F. during the summer. Many shallow lakes ranging from 20 to 40 feet may have summer bottom temperatures as high as 65° F. The difference between the summer surface and bottom temperatures may range from 10° to 20° F. depending on the depth.

Lakes of this type are located in rather fertile agricultural districts and are consequently rich in carbonates (40 - 200 p.p.m.) and other fertile elements. The bottoms support abundant vegetation and bottom fauna. The plankton is likewise very abundant. A thermocline is present below which the oxygen is scarce or absent from the colder water during the summer. The fishes are restricted to the water above the thermocline during the summer. Characteristic fishes for these lakes are wall-eyed pike and pickerel, or large-mouth black bass, crappie, sunfish, and suckers, or any combination of these species. Ciscoes may be found in a few of these lakes but they are never very abundant. Perch are always abundant in this type of lake. Such lakes are common throughout the central and north-central regions of Minnesota. As sometimes both bass and wall-eyed pike are present, it may be referred to as a dual purpose type of lake.

BASS AND CRAPPIE LAKE

This type of lake is shallow or moderately deep ranging from 15 to 100 feet in depth. It may be large or small, ranging from one-quarter of a mile to two miles in diameter. Tributary streams may or may not be present. The shores are usually composed of sand, mud, and gravel. Beds of marl are common.

The surface temperatures of these lake during the summer range from 75° to 83°F. The bottom temperatures vary considerably according to depth. Deeper lakes with a maximum depth ranging from 70 to 100 feet may have bottom temperatures as low as 45° F. The shallower lakes of this type with a maximum depth ranging from 20 to 40 feet may have the bottom temperatures as low as 65° F. The difference between the summer surface and bottom temperatures may range from 5° to 35° F. depending on the depth.

These lakes are located in fertile agricultural districts and are quite rich in carbonates (40 - 200 p.p.m.). These lakes produce abundant vegetation, bottom fauna, and plankton. A thermocline is present if the lake is over 25 feet in depth. The oxygen is scarce or absent during the summer in the water below thermocline. Fishes are restricted to the warm water above the thermocline during the summer. The characteristic fishes of these lakes are large mouth black bass, crappie, sunfishes, pickerel, and suckers. This type of lake is very common throughout southern, central, and north-central Minnesota.

BULLHEAD LAKE

This type of lake is rather shallow ranging from 6 to 15 feet in depth. It may be large or small, ranging from a fraction of a mile to several miles or more in diameter. Tributary and outlet streams may or may not be present. The shores are composed largely of mud although small areas of sand or gravel may be present. Such lakes are the warmest of the Minnesota lakes. The summer temperatures of the surface range from 75° to 80° F. Because of the shallow depth the bottom temperatures are seldom more than one degree lower.

These lakes are usually located in fertile farming areas and are rich in carbonates. They support a large amount of vegetation and plankton. The bottom fauna is sometimes scanty as it may be smothered by the soft mud. No thermocline is present and the oxygen although variable in summer, may be sufficient, but frequently in winter, due to the shallow depth may become too low for fish life. The characteristic fishes of such lakes are bullheads, carp, buffalo, and other rough fish. Pickerel may be present occasionally. This type of lake is common in southwestern and central Minnesota. In northern Minnesota this type is suited mostly for pickerel.

RIVER LAKE

This type of lake is moderately deep ranging from 20 to 70 feet. The area is frequently quite large. This is the type of lake through which a large stream flows and is really a lake-like expansion of a stream with many stream characters, which are not present in typical lakes. The shores are composed of sand, gravel, and mud. The river lakes frequently show a summer surface temperature ranging as high as 78° F. The bottom temperature is usually only 1° to 2° F. lower as the current keeps the water in circulation. Only in extreme conditions of low water levels and slow currents have differences as great as 7° F. been noted.

The surrounding land area is usually quite fertile and the lake is rich in carbonates. Frequently this type of lake supports an abundant amount of vegetation, bottom fauna, and plankton. No thermocline is present because of the currents from the stream and consequently the oxygen is abundant at the bottom throughout the summer. The characteristic fishes of this lake are wall-eyed pike, pickerel, large and small-mouth black bass, crappies, and many species of rough fish. The fish population is usually very abundant in individuals and usually contains more species than ordinarily found in other lakes. Lake St. Croix and Lake Pepin are outstanding lakes of this type in Minnesota.

The results of this general survey and classification of Minnesota lakes has been placed at the disposal of the State Division of Game and Fish for guidance in their planting operations. Surveys are still being continued on certain types of lakes where it is felt that not enough information has been secured particularly in regard to the productivity.

Here and there all over the state lakes occur which are designated as problem lakes. Many of these lakes which do not fit into the general classification are being studied at present. It seems that it is impossible to make a classification that will fit every case. There are always exceptions to the general rule. Frequently the physical and chemical conditions indicate that some lakes are more suitable for other species of fish than those already established. The fish which predominate are frequently undersized. This is clearly an indication that the fish already established are not thriving properly but their presence has heretofore prohibited the plantings of other fish to which these lakes are best suited. Some of these have been cases of pike lakes in which bass were predominating. The bass, although undersized, were abundant enough to destroy wall-eyed pike fry as fast as they were planted. Similar conditions exist in many so-called perchbound lakes. Other exceptions are frequently lakes which are found to be intergrades between several of the types set up in this classification. This classification has worked so far for most of the lakes of Minnesota.

WHY A WELL PLANNED FISH CULTURAL PROGRAM
IS NECESSARY, WITH COMMENTS ON TRANSPORT-
ING AND STOCKING FISH.

By Charles S. MacIntire, Fish Management Agent
Ohio Division of Conservation

THE LEGEND of "Why the sea is salt" is familiar to us all. According to the legend, an old man has his abode on the bottom of the sea and from his salt mill he tirelessly grinds out salt, nothing but salt. And for many people, the fish hatcheries are fish mills that grind out fish from the hatchery.

The aim seems to have been, and to a great extent still is, to produce as large a number of fish as possible and get them into the stream, with almost universal disregard for what may happen to them after they have been stocked. There has been, in recent years, a tendency to correct many evils; still, the percentage of loss between the hatchery and fisherman's creel is too great, for many of these stockings give no results whatever. Poor transportation, haphazard stocking, unfavorable stream conditions, or a combination of all three are among the causes of this loss. This is not wholly the fault of the applicant receiving the fish; we are all partially to blame. We have been too much interested in turning out a nice report of the number of fish hatched, reared, and stocked in the streams, and have not shown enough interest in the method, if any, of stocking, or what happened to them after being planted.

The average fisherman is primarily interested in the size and number of fish in his creel after a day's fishing. What difference does it make to him if the Conservation Department has increased its hatching and rearing facilities by 100 per cent or more, if the fish are not in the stream for him to catch? It makes no difference whether he is a bait fisherman or a dry fly purist, what he wants is fish in his creel at the end of a fishing trip to his favorite stream. The only thing that will justify the existence of our fish hatcheries and continuance of the fish cultural work, is more fish of a catchable size in the stream, awaiting the angler's bait or lure.

With the landing of white men in America, it was inevitable that the destruction of the habitat for our wildlife should begin. Timber had to be cut for fencing and building purposes, land had to be cleared for farming. Coal, and other minerals, and iron had to be mined; factories and mills and many other things that go along with civilization, had to be built; railroads and highways constructed; oil and gas wells drilled - all this was necessary for the industrial development of the country. But, should the development of our country have been so destructive of our wildlife and its habitat? The whole procedure seems to have been: Timber - cut out, burn out, and get out; farming - till the soil until the last drop of fertility has been exhausted, then let erosion, both wind and water, take its course; or intensive farming and grazing, that does not permit the leaving of trees or shrubbery on the steep slopes or along the stream banks and fence rows; coal - dig out the coal, let the top fall in, thereby losing the surface water and allowing the mine drainage to pollute the streams; oil and gas - drilling for oil and gas, and permitting the sand pumpings, salt water and waste oil to go where they may, polluting the streams and destroying

vegetation; mills and factories - construction of large mills and factories and other industries having the same thoughtless policy of dumping their destructive waste into the streams; cities and towns dumping raw sewage into the streams, giving no thought to the effect these practices would have upon the wildlife of woods and stream, and its habitat, or the effect it would have upon the future generations. In recent years the sportsmen, farmers, business and professional men, and the general public have awakened to the fact that the fishing known by our fathers is virtually a thing of the past.

In some of the more remote and inaccessible sections of the country Nature is doing a great deal to rehabilitate the streams and repopulate them with fish; but, with the great increase in the number of anglers, this process is too slow. One week of consistnt fishing by a group of anglers can depopulate a stream that Nature has had years to restore. It was seen that there must be another approach to the question of how to rehabilitate and repopulate the streams with fish. Everyone knew that fish lived in water, and there was water in the streams; so why not construct hatcheries, raise fish, and put them into the streams. Just like waving the magic wand, and Presto! streams full of fish, every angler filling his creel with fish, and everyone satisfied.

With the above in mind, many state conservation departments and the Federal Government constructed fish hatcheries and rearing stations, and raised millions of fish. The fish were planted (perhaps "dumped" would be the better word) by the million, with wonderful success in the newspaper columns and the Annual Reports, but with little or no success for the angler. It was then learned that water, just any kind of water, was not all that was required by the fish. There was something wrong with the water, stream formation or bottom and the watershed. There must be some system of diagnosis to determine the true condition of the stream and that species of fish life it will support. It was for this reason that the stream and lake survey program was instituted to determine the biological, ecological, chemical and topographic condition of the streams and lakes, and which species of fish were best adapted to any particular stream or lake. It has been doing a good piece of work in controlling and eradicating erosion and pollution, construction of devices to improve the environmental condtion, and to provide shade and cover. This was thought to be the "Magic Wand" and our streams and lakes would soon be full and overflowing with fish. For, why should they not be, we have constructed hatcheries and rearing stations, raised the fish to a size that are better able to withstand their natural enemies, improved their environmental conditions, and planted them in the stream or lake best adapted to the particular species being planted.

The sportsmen and a few conservation agencies yelled "Eureka" (whatever it means), the worm diggers and bait-catchers union raised their prices, the fly tiers started working over-time, and the prices of lines in New York, bamboo in China, and steel in Pittsburgh went up. Alas! we "Eurekaed" too soon." With all this work the angling public was not satisfied, for the fishing did not increase proportionately with the time and money spent on hatcheries, rearing stations, stream and lake surveys and improvements. In fact, many streams and lakes showed no increase whatever in the fish population, for notwithstanding all the aforementioned work and efforts we have, to a great measure, left one important link in the rehabilitation chain un-strengthened: that is, the transportation of and actual stocking the fish in the stream or lake.

It is an absolute fact that one of the most vital steps in the whole fish cultural program is the transporting of the fish to the stream or lake and stocking them therein. Why raise the fish if they are to be lost in transportation or through poor or ill-planned stocking methods? In the past, and in many instances in the present, when the fish truck or car leaves the fish cultural station, the man who has reared the fish from the eggs to the size of supposedly successful stocking must consider his responsibility at an end. Many times he will shake his head and say, "Another load of fish gone to the newspaper column."

The successful fish culturist must have years of training and experience and spend innumerable hours in reading and study to enable him to select the proper brood stock, prescribe and prepare the proper diet, guard against and eradicate disease and infection, thus insuring good, healthy fish that will produce the maximum number of eggs at time for spawning. He must watch over and care for the eggs during the incubation and hatching period, prepare food for the young fish and teach them to eat, guard against the unnumerable diseases and dangers that none but a fish culturist can appreciate.

In some instances the fry are taken from the hatching troughs or ponds to the rearing station where they are fed and cared for by a trained fish culturist until they are proper size for planting, or as in some states, until they reach legal size for catching. Then they are planted just prior to and during the open season. This is especially true of trout, in many states. Fish that have been cared for from the egg through every stage of development by well-trained fish culturists are so many times turned over to men to do what is one of the most important part of the work who are totally unfit, untrained, and not interested in this final and important part of the work — that of transporting and stocking the fish in the stream.

Listen, Sportsman! The next time you plan to place an application for fish, just ask yourself this question; "How much do I know about transporting and stocking fish? Do I have the money and time? Can I get adequate equipment for transportation and stocking?" In stocking fish, too many follow the hobo's commandment "When the load gets too heavy, lay it down."

The following is a true account of fish stocking by a sportsmen's club in 1934.

The Fish Committee had made application for 5,000 fish to be delivered on a specified date in front of the drugstore at 8:00 A.M. In due time they were notified on what day the fish would be delivered, and to have their own truck, cans, and a supply of ice; the fish truck and driver must return at once. The morning that the fish arrived there was one man on time to receive the fish. He called the Committee, and all were too busy but one; no cans, ice, or trucks had been provided for.

After much telephoning and confusion, a quantity of milk cans and two trucks were ready to take the fish; the cans were dirty and were washed at a fire hydrant; they should have been scalded with boiling water. The fish were finally put in them, and with four men and fifteen large milk cans on each truck, they got started at 11:00 A. M. One truck left the hard road 18 miles from town, the other 25 miles from town. Four miles up the side road the first truck found a large tree across the road, and had to turn back. The fish were dying, and they were dumped in the main stream along with catfish, carp, and water snakes; the other truck ran out of gas and dumped their fish in two small runs that usually go dry except for a few small pools.

The next day the local paper carried a news item with this heading "Local Sports men's Club plants 5000 four-inch fish. Join your local Club and do your bit for conservation." This is in no way an isolated case, but is all too true of so many fish stocking efforts. Can we not see why good intentions do not always produce the desired results, where we have handicapped the fish culturist, and conservation commission; and through lack of knowledge of the proper plans and procedure for successful fish stocking we are, in a way, responsible for the unsatisfactory results of the fish cultural program?

It can be truthfully said that conditions are changing and stocking methods are improving; but that if we are to receive the maximum benefits from our fish cultural and stream and lake rehabilitation program, the fish must be transported from the station to the stream, and stocked in the stream under the direct supervision of men trained and interested in the work. The transporting and stocking of the fish is just as important as raising them. And when the public comes to realize and understand this, they will demand that money be set aside to insure that all fish will be transported and stocked in the stream or lake under the direct supervision of men trained and interested in the work. In a few sections this procedure is now being followed to a degree, at least. In some sections where there are State or Federal forests or parks, they are receiving cooperation from these agencies and have a very good stocking program. Some states have discontinued delivering fish to local applicants, other states should follow the example, and do their own stocking; still, there is too much newspaper and Annual Report stocking.

Now that we are surveying the lakes and streams and classifying them by the species of fish best adapted to them, enlarging and modernizing our hatcheries and rearing stations, and by selective breeding and improved feeding methods, improving the strain of our brood fish, why not go one step farther and formulate an intelligent and well-planned stocking program and provide money to make sure that it will be properly executed?

When one stops to think of all the hazards and difficulties that must be met and overcome in the hatching and rearing the fish, the transportation and stocking of them in the lake or stream should be a comparatively easy job. Nevertheless, it does require special training, a lot of hard work, and a great deal of good common sense. Here is an outline of what is necessary.

Here is an outline of what is necessary.

Planning to meet the fish truck or car:

When an applicant receives notice of the day the fish are to arrive, he should make a written list of every piece of equipment that is to be used in the stocking operation. This should be collected at a central point and checked to make sure that nothing is left behind. He should make sure that every man to be used is thoroughly familiar with his part of the work. The road or roads must be scouted and plainly marked. If the fish are to be stocked at different points or sections of the lake or stream, every such place should be plainly marked and the number of fish and cans designated. If the fish are to be delivered by rail or one or more large trucks and transferred to other cans and trucks, the applicant must be sure that there will be sufficient number of cans and trucks. Do not plan on crowding or doubling two cans

of fish into one. Make sure that the cans are clean and have been scalded out with boiling water. It will be much better to have several small trucks than a few large ones, but have sufficient number of trucks and cans. Have one small pail, 10 or 12 quart size, and a long handled dipper that will go into the top of the can, for it may be necessary to aerate or add to the water in the cans. If it is necessary to aerate the water, this should be done by dipping the water and pouring it from a height of two or three feet, back into the can. The fish will have been iced before leaving the station; but to be safe, there should be enough ice on hand to allow a 5 pound piece for each can.

Arrival of Fish:

Now is the time to be quick. Do not delay, for delay often means the loss of fish. Action is imperative, and the fish must be transferred and under way as quickly as possible. Do not be afraid of rough roads or jostling the cans, for this will help to aerate the water. Have one or two men to ride in the back of the truck and watch the fish in the cans. If they begin to "come up" he must re-aerate the water. He should remove all the lids, and take the cans in order. Dip the water and pour it back from a height of two or three feet, and replace the lids as each can has been aerated. In this way he will not miss any of them. Start at the beginning, and repeat the process until the fish cease to show signs of distress.

At the Stream Side or Lake Shore:

When the truck has reached the stream or lake, proceed to each distribution point and unload the number of cans designated. Now the time has come when the work can be done more slowly, and care should be exercised to make sure that the actual stocking is properly done. At each distribution point there must be someone who thoroughly understands the work and will see that it is properly done. A little ignorance, negligence, or carelessness at this stage may destroy all the work that has gone before.

Now, the tempering process should begin; that is, bringing the temperature of the water in the cans to that of that water in which the fish are to be stocked. It must be remembered that the water in which the fish have been raised may be decidedly different chemically from that in which they are to be stocked. Therefore, the fish must be partly acclimated to the water in their new home before being turned loose in it. The tempering should be done by pouring out half or more of the water in the can and refilling it from the stream. This should be repeated until the water in the cans is within one or two degrees of that in the stream or lake. It must be kept in mind that the temperature of the water will change much faster than that of the fish; therefore, the tempering process must not be hurried.

Stocking the Fish:

As stated above, the fish to be stocked should be unloaded at different points along the stream or around the lake shore. This will simplify the work and make the distribution much easier. When a lake is being stocked it may be possible to unload all the fish at one point and take them to the distribution points by boat. If this is to be done, make sure that there are a sufficient number of boats to carry the cans without too much delay, and that there are men who are familiar with handling the boats.

When the fish are to be carried very far, one will find that the Fearnow fish pail or the ordinary milk can is heavy, cumbersome, and hard to carry. It will be much better to provide each man with two pails of 14 or 16 quart capacity, for these will be much easier to carry. Always start stocking at the most distant point; the fish are in good condition and are better able to stand the long carry than they will be after having been left in the cans for some time. The fish remaining in the cans can be left for any reasonable period of time if the cans are placed in the lake or stream, and tipped until there is a circulation of lake or stream water. A number of square pieces of cloth such as mosquito netting or bobbinet should be provided to tie over the pails being carried and the cans left in the water. All cloth will shrink when wet, so cut the squares large enough to allow for shrinkage. Ordinary chalkline or binder-twine will be suitable for tying the cloth over the pails and cans.

Good judgment should be used in determining just where to release the fish. They are tired from their long journey, the surroundings new, the new home is much different from the rearing trough or pond from which they were taken. They should never be placed in deep dark pools, or the main body of the lake which may be inhabited by large fish or other predators; they should not be placed in the swift current of riffles or rapids where they may be washed down into the pools or dashed against the rocks and injured; they should not be released in large numbers at any one point, because if so released they will school up as they did at the rearing station and become prey for their natural enemies. They should be released a few in each place, in shallow water, a slow current, and where they can find food, shelter, and a place to rest where they will be safe from their natural enemies.

Fish Holding Box:

There are times when it is impossible, for some reason or other, to stock the fish on the day they arrive, and they must be put in a "holding box" to save them. For such a box, it is best to get light dimension material of good hard wood, and make a frame 6' x 3' x 2', put together with brass screws. It will also be a good plan to reinforce the corners with brass angle irons, put on with brass screws. Cover the sides, ends, and bottoms with a good grade of copper screen wire. Make the top in a separate section so it can be fastened with hook and eyed screws, so it can be taken off and put out of the way when the fish are being removed. Give the frame two coats of good paint to protect it from the water. A net is necessary to remove the fish from the holding box. It should be made of heavy gauge wire, with sides and end square. Bobbinet will make a good material for covering the frame.

The holding box should be placed about 1/2 or 2/3 of its depth in the water, where there is a slight current. When the fish have been tempered they can be placed in the holding box and all stocking done from it. A number of holding boxes may be used, and placed at different points along the stream or lake. This will simplify the stocking and prevent the loss of fish. A box the size described will hold a load of from 15 to 20 Fearnow pails of fish.

A LITTLE EDITORIAL

REBUILDING AMERICA'S RESOURCES

Sir Christopher Wrenn, the great architect, once approached a group of workmen and asked, "What are you doing?"

The first replied sourly, "I'm earning twelve shillings a week."

The second said stolidly, "I'm mixing mortar."

The third said proudly, "I'm building a cathedral."

Fish Culturists, what are you doing?

NOTICE REGARDING CHANGE OF ADDRESS

IT IS THE AIM of the Bureau to maintain an up-to-date mailing list for THE PROGRESSIVE FISH CULTURIST and to record promptly requests for change of address. Owing to the method of filing address cards and maintaining the addressograph plates, it is important that anyone requesting a change of address notify this office of both the old and the new address.

COMMENTS FROM OUR READERS

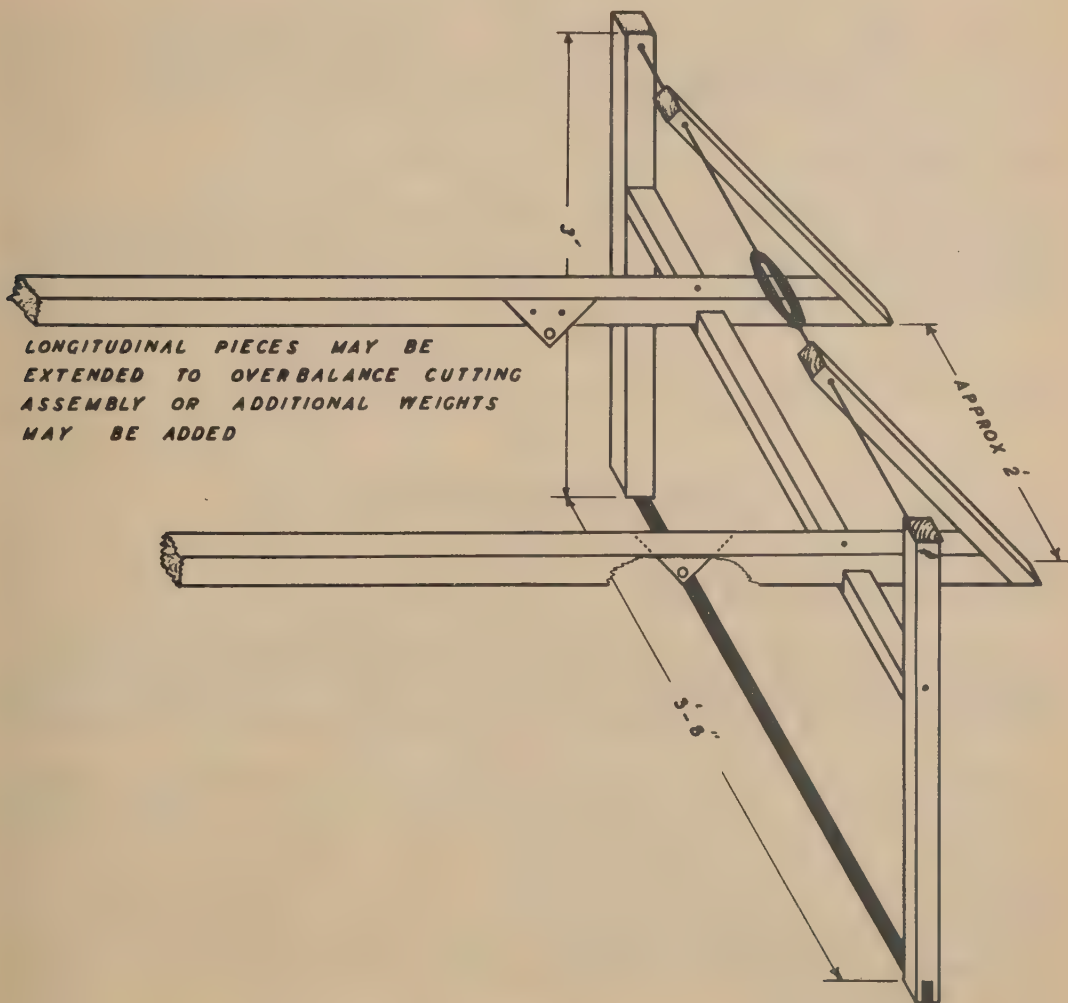
A SIMPLE WEED CUTTER FOR PONDS

EDITOR, THE PROGRESSIVE FISH CULTURIST:

I wish to take this opportunity to thank you and the rest of your staff for the PROGRESSIVE FISH CULTURIST magazine. I find it very instructive and interesting.

I am only a "caretaker" on a one man station. However, other men in the same position will know that one's duties just about cover the list, such as grinding meats and feeding, general maintenance of grounds, etc. As the duties here require from eight to ten, sometimes twelve hours work a day, I have been trying to devise means of shortening the hours spent on the various duties, such as cutting weeds, etc. One of my main nuisances is the Japanese Lotus, which a misguided park commissioner had planted in the ponds before the Bureau took this station over. They are just about the fastest growing water plants I ever saw. They require cutting at least twice a week; in extremely hot weather sometimes three times. For that reason, and in the hope that I may be able to help some person who is up against the same proposition, I submit the enclosed sketch of a simple cutter that I rigged up for cutting weeds.

I have listed the approximate cost of making the cutter. However, the one I made did not cost me anything, as I made it from scrap material found on the station. I feel sure that materials used are obtainable in the scrap piles of most any station. The blade is made from a Victrola phonograph spring which can be obtained at almost any furniture store for nothing. Just ask for a broken spring. If any person



cannot find one, write me and I will gladly send one, as the fellow that I asked for the one I used gave me a bushel box full.

The cutter can be made much better if the vertical pieces were made of 1" angle iron, as it would offer less resistance when being forced through the water while cutting.

After assembling the cutter, screw the bottom pieces of the pivots or hinge to the back seat of the boat in such a manner that the holes correspond with the ones on the cutter, then lock same together by inserting a ten penny nail in the holes. The pivot on the horizontal bars should be near enough to the vertical pieces that they cause the center of gravity to be to the left of the pivots. In other words, the horizontal bars should be long enough so that they barely over balance the front framing and the blade, plus a five-pound weight or "pull down" on the blade.

The framing should be flexible so that in case it should come in contact with the slope of a dam it would have a give to it. For that reason in fitting the cross bar to the horizontals and verticals do not cut the notches too close, or set up on the bolts too much. The turnbuckle at the top should be tight at all times, as it keeps the blade tight.

It is best to use the cutter when a light breeze is blowing as it blows the cut weeds out of the way. Otherwise, it will be hard to tell where you have cut on the next trip around the pond.

Wesley B. Solomons
St. Matthews Station
St. Matthews, S. C.

CRAYFISH AFFECTS FISH PRODUCTION

EDITOR, PROGRESSIVE FISH CULTURIST:

During the past few years I have made the following observations upon the production of the crayfish, Cambarus immunis, in my bluegill rearing ponds. Although crayfish are found in all of my ponds, production data were taken on only one pond.

The No. 1 Belmont Pond is the first in a series of three ponds located at Belmont, Kent County, Michigan. These ponds have been in use for over twenty years. The pond has an area of 4.35 acres, and a maximum depth of nine feet. The pond has a muddy bottom covered with a dense growth of Chara from shore to a depth of eight feet. The water is supplied by a small, clear spring creek. Water temperatures range from 58 F. to 70 F. in mid-summer. The number of bluegills planted each year is the same (approximately 200,000 during 1935, 1936 and 1937) and the pond is drained at about the same time each fall.

Until the year 1935 there were very few crayfish, and the water was clear. In 1935 crayfish appeared in large numbers, and as a consequence the water was roily and the plant growth was scanty. The total number of crayfish was smaller in 1934 than in the subsequent years, and the size of the bluegills was larger. The following table is self-explanatory.

Production of Bluegills and Crayfish
in No. 1 Belmont Pond

Year	No. of	Total Wt. of	No. of	No. Bluegills	Total
	Crayfish	Crayfish in Pounds	Bluegills	Per Pound	pounds of Bluegills
1934	Very few		95,000	300	317
1935	604,000	3020	143,000	1000	143
1936	600,000	3000	152,000	1000	152
1937	659,000	3527	160,000	1100	146

All of the crayfish listed above were removed by seining. A one-half inch bar seine, heavily leaded, was used. The fish were usually near the surface of the water and were able to swim through the net. In this manner the larger crayfish could be removed at intervals throughout the summer. Before seining operations were attempted, the water was lowered to facilitate seining. At times liver and dead fish thrown in one side of the lake successfully attracted the crayfish to that end of the pond.

By removing the majority of the crayfish before the ponds are drained, large numbers of fish are saved from the pinchers of the crayfish.

I think that crayfish are a detriment to bluegill ponds, especially those ponds in which no artificial feeding is attempted. Crayfish keep the vegetation cleaned out and also make the water roily, thereby cutting down the amount of natural food. A large number of fish are killed by crayfish when the ponds are drained. I have decided to plant bass in these ponds and use minnows for forage.

During the summer of 1937 approximately three tons of crayfish were removed from the various ponds at the Comstock Park Hatchery. Approximately one ton of these were fed to adult small-mouth bass. I find that adult small-mouth prefer crayfish, at times refusing to eat any of the artificial prepared foods or minnows. The rest of the crayfish taken in 1937 were planted in various lakes and streams in the vicinity of Grand Rapids.

Claude Lydell
Lydell Fish Hatchery
Comstock Park, Mich.

NOTES AND NEWS

ANGLERS SPEND OVER 9 MILLION DOLLARS FOR LICENSES

ANGLERS IN the United States bought 6,901,587 licenses during 1936-37 for which they paid \$9,309,949, according to Charles E. Jackson, Deputy Commissioner, Bureau of Fisheries. More than 89,000 anglers' licenses were sold to women and children, although many states permit women and children to fish without a license. In 1932-33, there were only 4,858,058 licensed anglers.

The total number of regular fishing licenses issued to residents and non-residents in 1936-37 was 4,952,775, while combination licenses (hunting and fishing) numbered 1,948,812. Of the 6,901,587 licenses issued of all classes, 6,234,478 were purchased by residents, and 667,109 by non-residents. Thirty States, where short term licenses are sold, reported the sale of 223,128 tourist licenses.

While the states gained over \$2,500,000 in revenue from the sale of anglers' licenses from 1932-33 to 1936-37, on an average they received 5 cents less for every license issued in 1936-37, than in 1932-33, when the average license fee was \$1.39 as against \$1.34 in 1936-37.

Figures obtained from the State Fish and Game Departments of Alabama, Arkansas, California, Indiana, Maine, Maryland, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, South Carolina, Tennessee, Texas, Utah and Washington, show an estimated \$136,485,212 spent by their 1,533,321 licensed anglers in 1936-37. Expenditures for tackle, bait, transportation, guides, boats, gasoline, food, lodging and other equipment in these states averaged \$87.33. Fishing license fees averaged \$1.68. Less than 2 percent of their total average expenditure of \$89.01 found its way into the State Fish and Game Departments for the enforcement of the fish laws, educational work, administration, the raising of fish and restocking programs. In this connection it is interesting to note the ratio of daily catch per angler compared with daily limit as reported by 11 States: Alabama 25 percent, California about 20 percent, Florida, 60 percent, Idaho, 50 percent, Maine, 8 percent, Maryland 70 percent, New Mexico 30 percent, Rhode Island 30 percent, South Dakota 60 percent, Utah 30 percent, and Washington 60 percent - or a general average of 40 percent.

When less than 2 percent of the anglers' expenditures is allotted to the State Game and Fish Departments for their work, that an angler is able to catch 40 percent of the daily limit shows the provident use of license money by the states in carefully managed and financed programs.

REVIEWS

THE PHYSIOLOGY OF RESPIRATION IN FISHES

Leiner, Michael, 1938. Die Physiologie der Fischatmung. Akademische Verlagsgesellschaft M. B. H. 117 Illust. p. 134.

This combination monograph-review brings up to date the problems and researches in fish respiration since the publication of the section on "Respiration of Fishes" in "Bronns Klassen and Ordnungen", of which this author was a collaborator with Prof. M. Rauther.

This booklet aims to emphasize the wide variety of physiological possibilities used by fishes in accomplishing problems of O₂ uptake. Furthermore, this study shows how much more dependent, on the environment, is the water breather than the air breathing homothermous vertebrates which have attained maximum independence, of all animals, from external conditions.

The literature is treated more with the aim toward a descriptive review than toward completeness. There are 313 titles in the bibliography to which reference is made by number and the authors name whose results are quoted. Of 117 figures, 28 are original.

The 5 chapters consider the following topics: 1 External and internal environment in fish respiration, and including water as a respiratory medium and blood as a carrier of respiratory gases. 2. The gill system, including the anatomical and histological structure and transport of water to the gills. 3. The function of the gills as breathing organs, including the O₂ utilization under normal requirements, the dependence of respiration on O₂ tension bicarbonate content of water, on temperature, and on osmotic pressure. 4. Embryonic respiration. 5. The function of supplementary respiratory organs including breathing through mucous membranes of the mouth, gullet, gill cavity, and gill derivatives, the latter having subdivisions on labyrinth fishes, air breathing in Amphipnous and Electrophorus and intestinal respiration, the swim bladder and gaseous exchange, the swimbladder of phyostoma and physoclisti and lung respiration. 6. The function of pseudobranchae, the acidophile cells in all respiratory organs of fishes and the glands of the swimbladder wall.

The author's work on Hippocampus is reviewed. Special emphasis is placed on the quantity of carboxyanhydrase present in different tissues to facilitate CO₂ elimination. The pseudobranchiae of most bony fishes contained very active enzymes which catalyze the reaction $\text{H}_2\text{CO}_3 \rightleftharpoons \text{CO}_2 + \text{H}_2\text{O}$. The anterior end of the swimbladder of physoclisti was also rich in these enzymes.

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THE LIFE STORY OF THE FISH

Brian Curtis. D. Appleton-Century Company, Inc., New York. 1938. 260 pages. 36 figures. 14 diagrams.

"The Life Story of the Fish" has already been reviewed in glowing terms in a number of publications. Hence, the present reviewer undertook its reading with a keen interest but with a tinge of skepticism toward "another popular fish book". The introduction by William Beebe which is less introductory and more a glowing eulogy of the author's labors still further whetted one's interest for he says:

"When a man, be he ichthyologist or human being, can tell us in excellent English and with a sense of humor of a fish's skeleton, can enlarge with technical accuracy and contagious amusement upon swim-bladders, can find intellectual stimulus together with divertisement in the internal workings of a shark, when he can give to the habits and home life of a fish a sympathy which makes them faint adumbrations of our own, then he has written a jolly good book."

And, in this reviewer's opinion, also, Brian Curtis has written a jolly good book. In twelve chapters, some of them disappointingly short and others of more satisfying length, the author has combined a discriminating review of the pertinent literature with his own personal observations over a period of years and has produced a very satisfactory factual account of the structure, habits, and adaptations of fishes. He has clothed this skeleton of fact with familiar illustrations from everyday experience and embellished it with wit, speculation, and personal views that make the entire volume delightful reading.

In the various chapters he defines a fish and places it properly in the scheme of nature. He describes the body covering, the framework, the senses and the nervous system, the air bladder, and "internal workings" with sufficient detail to give even to the beginner or casual reader a very fair understanding of the fish's organic mechanism. Then, there follows still more interesting chapters on reproduction and growth, trout and salmon, and other game-fish, and finally under the heading of "Habits and Adaptations" a whole museum display of peculiarities of Nature exemplified by the bizarre and remarkable forms of fish developed in the process of adapting themselves to the wide variety of circumstances in fresh and salt water.

Space prohibits regaling you with the many delicious tidbits of thought and treatment throughout the book. Perhaps the most amusing ones are repeated comparisons of the structure and activities of the fish with corresponding ones among other animals and man himself. Here is one from the chapter on "Body Covering" which gave me a chuckle:

"In the first place, the fish's skin is alive. The very outermost covering, the covering which comes in contact with the great world, is composed of living cells. This is not the case with us, for the living part of our skin is covered with several layers of hardened cells which, although transparent, are completely dead. They protect the living cells underneath. When you touch another human being, you do not come in contact with living flesh-- unless you are a dentist, who, if you are a little clumsy, the dead skin of your finger may come in contact with the living cells which line the mouth of the patient--or unless you are engaged in amorous activities, which is practically the only occasion when the truly living parts of two separate human individuals come in contact with each other."

But, in a less popular vein and with more satisfying analysis, the chapter on the "Senses and the Nervous System" is worthy of praise. We know little from human experience about the sight of fish; yet with a series of diagrams the physics of light and its refraction in passing from air to water or the reverse and the structure of the fish's eye are fully explained and compared with other animals. As well as a human being can, the author has demonstrated what a fish can see and arrives at the startling conclusion that to a trout in deep water a fisherman standing on the bank occupies more of his area of vision and therefore looks larger than when the trout rises to the surface. "In other words", "Curtis says, the nearer he comes to you, provided he confines himself to moving straight upward, the smaller you look to him. This is just the reverse of our own impressions, for the nearer we come to things, the larger they look to us. The fish must have a pretty cockeyed idea of what the world above water is like, but, as he is used to it, it doubtless seems perfectly normal to him. Which leads us to speculate as to what distortions there are in our own view of the universe, and how far it is from being the normal which it appears to our eyes."

The book has been written frankly for the two largest classes of people who are interested in fish--the aquarists and the sportsmen, but to those of us who have had some training in biology or are professionally concerned with fish from the point of view of operating fish hatcheries or the more general view of conservation and fish management--to all of us in these categories, at least below the intellectual level of the professional ichthyologist, the book is most satisfying because it reminds us of so many facts once learned but now half forgotten and because it brings together and relates from points of view that are frequently fresh and novel a great deal of information and understanding that should be a part of our daily thinking.

The "general public" will read the book because it is entertaining; the student of Nature will read it because it is stimulating. To every fish culturist and conservationist I wholeheartedly recommend it because its reading will provide a sounder background for clearer thinking and a better appreciation of the importance of his work.

Elmer Higgins.

